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LEAD-INDUCED DAMAGE TO EMBRYOS IN CATTLE

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LEAD-INDUCED DAMAGE TO EMBRYOS IN CATTLE?

[Bleibedingte Keimschäden beim Weidevieh?]

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LEAD-INDUCED DAMAGE TO EMBRYOS IN CATTLE?

The question of how much lead dust from the exhaust gas of motor vehicles (as a result of the use of lead alkylene as an anti-knock agent) settles on the earth surface including the vegetation, either together with precipitation or - near the highways - directly, also has been investigated in German-speaking countries (Kloke et al, 1966; Patel, 1967; Suchodoller, 1967; Kern, 1968; Kloke, 1969). The question of embryonic damage as a result of environmental lead does not yet seem to have claimed the attention of veterinary medicine, although the non-scientific press has reported from time to time that cows abort near the highway.

Today, thanks to the above-mentioned research, we are in a position to approximately estimate the lead amounts ingested by grazing animals. Furthermore, an unfortunately little known publication by Egorova et al. (1966) gives lead dosages causing damage to sperm in male warm-blooded animals. Thus, by comparing the values, we can arrive at a judgment as to whether lead-induced andrological damages should be expected today in grazing animals. The result should also be gynecologically relevant.

According to Kloke et al. (1966) a lead content of 32 to 36 ppm Pb can be expected to be present in the dry substance of grass in the vicinity of roads with heavy traffic (5 m distance), and in zones away from traffic with 6.6 to 9.8 µg Pb/kg dry substance. The values are considerably higher in the Ruhr area because of industrial emissions. According to Kloke (1969), the pollution of vegetation with lead dust depends, in addition to the density of the traffic and distance to the highway, on exposure time of the

plant organ, on its surface and on its slope to the horizontal, the amount and distribution of precipitation and on the direction and force of the wind.

With a daily requirement of 0.1 kg grass/kg body weight and a 17% content of dry substance of the grass, the 6.5 to 9.8 µg Pb/kg dry substance given by Kloke et al (1966) for areas away from traffic, result in oral daily intake of 112 to 167 µg Pb/kg body weight.

Compared with oral lead absorption by a person (Patterson 1965: about 5 µg/kg, estimate by Kloke et al (1966) 21 µg/kg) the values for cattle are high, particularly since according to Aebi (1956) constant oral intake of 1 mg/day, or about 14 µg/kg and day already has pathological effect. The following lead sources must be added:

1. The lead dust concentration has far exceeded the Soviet tolerance value in densely settled areas and in imission areas of steel mills (Stoeffen 1968). In special cases, the lead intake by the respiratory organs considerably increases for cattle also, throughrust removing work on lead-painted bridges, for example.

2. Licking of lead-painted iron posts, etc.

3. Lead-migration from water pipes made of lead in the stable, especially when the water is soft. According to Reed et al (1967), today's practice of adding chemicals to surface water causes increased lead-migration in old pipes, too.

4. It has not yet been taken into consideration that lead dust is carried into the stables with hay and straw. This lead dust gets into the air of the room by crumbling of the hay or straw and is inhaled, or onto the animals' coat and thus is ingested by skin resorption or orally by licking the coat.

The following circumstances must be taken into consideration when estimating the dangers of lead to the cattle:

1. Doses usually start with 200 µg Pb/kg body weight and day, oral, in chronical toxicological experiments.

2. The most serious effects of lead start in man when he is older (with the exception of perinatal effects) (Dingwall - Fordyce, 1963), when his reproductive power ceases, an age which animals hardly reach.

3. Man has many additional loads which the animal does not have.

The following viewpoints also must be considered.

1. The animal world, too, is burdened more and more with pathologically acting factors (insecticides, antibiotics, hormones).

2. According to Lehnert (1968), the toxic effects of lead depend less on the height of the blood lead level, which normally remains constant when the Pb supply is constant, than on the intensity of exogenous and endogenous lead flows into the blood which cause "disturbances" in biological control systems. However, local (move by cattle to areas near highways or wind-protected zones) and time variations (drought periods, rain, coarse fodder of different origin) in lead absorption always are possible.

3. The effects of lead on the psyche start much earlier than physiopathological effects (Egorova et al, 1966), and those on embryonal life even earlier (Egorova et al, 1966; Púhac et al, 1963).

The pathological damages caused by lead cannot be excluded for grazing animals, considering today's conditions. According to Selye (1966), and to Slavkov et al (1968) lead sensitizes the organism for allergens. Slavkov et al also confirm that leadcauses a decrease in immunobiological reactivity. The sensitivity to allergens perhaps explains the increase of skin tetter in cattle, which is under discussion by experts.

The danger of embryo damage in grazing animals seems to be exceptionally great. Lead inhibits the synthesis of ribonucleic acid, which takes part in the building of genes (Oltramare, 1964; Skoczynski et al, 1967) for example. It causes mutations in lepidoptera, which was confirmed by experiments with moths. Ferm et al (1967) found tail abnormalities, no eyes, fused ribs, split vertebrae and misplaced brains in experiments with warm-blooded animals (with high doses). According to Tarabaeva (1960), the lead poison causes insufficiency of ovaries and menstrual disorders in human beings. The lead is mobilized during pregnancy, so that it penetrates the fetus through the placenta. The consequences are sterility, premature birth and miscarriages, and increased child mortality. The milk of lead-poisoned mothers contains the poison in a higher concentration. According to Tarabaeva, the newly born often show damage of the brain (hydrocephalus, idiocy and convulsions) but also infantilism and rachitis.

The andrological effects of the metal consist of an atrophy of the seminiferous canals and of a damage of the parenchyma of the sexual glands. As a result, the spermiogenesis is disturbed during the stage of the partition of the spermatocytes, and the spermatozoons gradually disappear. Egorova et al (1966) found in experiments that testicles and sperms were already affected by lead doses, which did not even lead to nervous disorders (6 times 0.002 mg Pb/kg body weight in 10 days, oral). Morphologically and histologically, edema were found in the interstitial tissue, destructions in the walls between the seminiferous canals, peeling off of the basal membrane, passage of sexual cells into the lumen of the canals, dying of sexual cells, and in some cases (higher doses), necrosis of the seminiferous canals and inflammation filtrates in the interstitial tissue. The ribonucleic acid synthesis greatly decreased in the partitioning sexual cells. In some cases mitoses and cells with longated pear-shaped nuclei are formed, some cells greatly increased in dimension. Numerous pathological shapes showed in the microscopic preparations.

It is astonishing, yes even puzzling, that the same effects occurred with a 100,000 times higher dose (6 times 200 mg/kg body weight, oral, in 10 days). Without a doubt, the stress of sexual excitement plays a part. According to Professioal'nyu bolezni, 1964, stress aggravates lead poisoning, keeping in mind a mobilization of accumulate lead. Accordingly, an endogenous supply of lead must have been present in addition to the exogenous one - perhaps there were even other poisons which could be mobilized. In view of the strong radiation in procreative processes we would have to keep in mind the possibility of biophysical effects, probably in the sense of Szent Gyoergy. According to an oral report by the Russian researcher Rubis, Vladivostok, lead occupies a singular position as far as biophysics

are concerned. The lead mobilization test should be included when the work of Egorova et al (1966) is checked. Then we would have a measure for the extent of lead amounts which can be mobilized in the organism.

Gynecologically, Kasbohm (1965) reported about the increase in ovarian disorders in cattle. Inquiries at insemination stations, show that an increasing number of bulls are no longer used because of sperm damage and that others secrete damaged sperm at an increased rate at irregular intervals.

Lead-induced sperm damage might be accessible to lead removal therapy by chelating agents.

Research in lead-induced fetal damages by veterinary medical science could also be useful for the human medical science and for other anthropological fields. For example, it could be possible that many diseases, which seem to be inherited through genes, but the genetic typing of which is very difficult because of the uncertainty of the inheritance prognosis, is caused in reality by environmental poisons. According to Sanockij, organic chlorine insecticides, too, act perinatally the same as lead, and other heavy metals.

Future developments with respect to this problem cannot be viewed with optimism. Automobile traffic and the use of supergas with higher lead alkylene content are on the increase. The amounts of lead reaching the ground accumulate there. It is possible that the lead which is absorbed by ground fauna, forms compounds which can be absorbed easier by the plants after the putrefaction of these animals, at this time, the resorption from the ground (with the exception of roots) by plants with a one-year growth is still small (Kloke et al, 1966). Patterson (1965) states that the

lead content in the individual annual rings of trees increases constantly. Manufacture of lead-free gasoline is technically and economically possible - for example AMOCO, Chicago, sells such a gasoline at a price which is only 1-2 cents/gallon higher (about 1.05 to 2.1 Pf/liter) in the eastern states of the USA and is extending its plants. However, resistance against the introduction of lead-free gasoline is high. After actual damages caused by lead have been worked out in more detail by research, the appropriate authorities probably will have a better chance of taking the necessary measures.

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VERLAG PAUL PAREY · BERLIN UND HAMBURG

Bleibedingte Keimschäden beim Weidevieh?

Von D. STÖFEN

Inhalt: *Ein Vergleich der Bleimengen, die nach* KLOKE *et al (1966) die Vegetation und auch das Gras verschmutzen, mit den Bleiquantitäten, die nach einer kaum bekannten Arbeit von* EGOROVA *et al (1966) Spermaschäden verursachen, zwingen zu dem Schluß, daß solche Schäden bei weidenden Haustieren stark zugenommen haben müssen.*

Contents: *A comparison of the amounts of lead which, according to* KLOKE *et al. (1966) were found to pollute vegetation and grass, and the quantities of lead recorded in a little-known study by* EGOROVA *et al. (1966) as causing damage to sperm, leads us to the conclusion that damage of this kind must have increased considerably in grazing cattle.*

Die Frage, welche Bleistaubmengen aus den Abgasen der Kraftfahrzeuge (als Folge der Verwendung von Bleialkylen als Antiklopfmittel) sich auf der Erdoberfläche einschließlich der Vegetation niederschlagen, entweder zusammen mit Niederschlägen oder — vor allem in Autobahnnähe — unmittelbar, ist auch im deutschsprachigen Raum verschiedentlich untersucht worden (KLOKE et al, 1966; PATEL, 1967; SUCHODOLLER, 1967; KERIN, 1968; KLOKE, 1969). Obgleich in der nichtwissenschaftlichen Presse gelegentlich über Verkalben von Kühen in Autobahnnähe berichtet worden ist, scheint die Frage der Keimschäden durch Umweltblei noch nicht die Aufmerksamkeit der Veterinärmedizin gefunden zu haben.

Erfreulicherweise können wir heute dank den genannten Arbeiten die vom Weidevieh inkorporierten Bleimengen ungefähr abschätzen. Ferner sind aus einer leider praktisch unbekannt gebliebenen Publikation von EGOROVA et al (1966) die Bleidosen ersichtlich, die bei männlichen Warmblütern keimschädigend wirken. Durch Nebeneinanderstellen der Werte können wir also zu einem Urteil kommen, ob bleibedingte andro-

logische Schäden heute beim Weidevieh zu erwarten sind. Das Ergebnis dürfte auch gynäkologisch relevant sein.

Nach KLOKE et al (1966) kann in der Nähe von stark befahrenen Straßen (5 m Abstand) mit einem Bleigehalt von 32 bis 36 ppm Pb in der Trockensubstanz von Gras gerechnet werden, in verkehrsabgelegenen Zonen immerhin mit 6,6 bis 9,8 µg Pb/g Trockensubstanz. Im Ruhrgebiet liegen die Werte wegen der Industrieemissionen wesentlich höher. Nach KLOKE (1969) hängt die Verschmutzung der Vegetation mit Bleistaub außer von der Verkehrsdichte und von dem Abstand zur Autobahn noch von der Expositionszeit der Pflanzenorgane, ihrer Oberflächenbeschaffenheit und ihrer Neigung zur Horizontalen, der Menge und Verteilung der Niederschläge und von Windrichtung und Windstärke ab.

Bei einem Tagesbedarf von 0,1 kg Gras/kg Körpergewicht und einem Gehalt des Grases an Trockensubstanz von 17 % bewirken die von KLOKE et al (1966) für verkehrsabgelegene Zonen genannten 6,6 bis 9,8 µg Pb/g Trockensubstanz eine orale Tagesinkorporierung von 112 bis 167 µg Pb/kg Körpergewicht.

Verglichen mit der oralen Bleiaufnahme des Zivilisierten (PATTERSON 1965: etwa 5 µg/kg; Schätzung KLOKE et al (1966) 21 µg/kg) sind die Werte für das Rind hoch, zumal nach AEBI (1956) dauernde orale Inkorporierung von 1 mg/Tag oder etwa 14 µg/kg und Tag bereits pathologisch wirken. Folgende Bleiquellen kommen hinzu:

1. Die Bleistaubkonzentration hat in Ballungszentren und im Immissionsbereich von Hüttenwerken den sowjetischen Toleranzwert weit überschritten (STÖFEN 1968); in Sonderfällen steigt die Bleiinkorporierung durch die Atmungsorgane auch für Weidevieh erheblich an, z. B. bei Entrostungsarbeiten an bleigestrichenen Brücken.
2. Belecken von bleigestrichenen Eisenpfählen und dgl.
3. Bleiauswanderung aus Wasseranschlußleitungen im Stall aus Blei, besonders wenn das Wasser weich ist. Nach REED et al (1967) bewirkt die heutige Chemisierung des Oberflächenwassers eine erhöhte Bleiauswanderung auch in alten Leitungen.
4. Es ist noch nicht beachtet worden, daß mit dem Heu und mit dem Stroh logischerweise auch Bleistaub in die Ställe getragen wird, der einerseits durch Zerbröseln in die Raumluft gelangt und eingeatmet wird, andererseits auf das Fell und dann durch Hautresorption oder durch Fellablecken oral inkorporiert wird.

Bei einer Abschätzung der Gefahren durch Blei für Weidevieh müssen folgende Umstände bedacht werden:

1. In chronischen toxikologischen Experimenten beginnen die Dosen meist bei 200 µg Pb/kg Körpergewicht und Tag, oral.
2. Die schwerwiegendsten Auswirkungen des Bleis setzen (von den perinatalen abgesehen) beim Menschen erst in höherem Alter ein (DINGWALL-FORDYCE, 1963), beim Erlöschen der Fortpflanzungsfähigkeit, ein Alter, das Tiere kaum erreichen.
3. Beim Menschen kommen zahlreiche Belastungen hinzu, die das Tier nicht kennt.

In die andere Waagschale gehören folgende Gesichtspunkte:

1. Auch die Tierwelt wird immer mehr mit pathologisch wirkenden Faktoren belastet, z. B. Insektizide, Antibiotika, Hormone.
2. Nach LEHNERT (1968) hängen die toxischen Wirkungen des Bleis weniger von der Höhe des Blutbleispiegels ab, der bei gleichbleibender Pb-Zufuhr normalerweise konstant bleibt, als von der Intensität exogener oder endogener Bleianflutungen ins Blut, die „Störaufschaltungen" biologischer Regelkreise bewirken. Schwankungen in der Bleiaufnahme sind aber lokal (Übertritt von Weidevieh in autobahnnahe oder windgeschützte Zonen) und zeitlich (Trockenheitsperioden, Regen, Rauhfutter verschiedener Herkunft) immer möglich.
3. Die Auswirkungen des Bleis auf die Psyche setzen bereits viel früher ein als die physiopathologischen (EGOROVA et al, 1966), die auf das keimende Leben noch früher (EGOROVA et al, 1966; PUHAČ et al, 1963).